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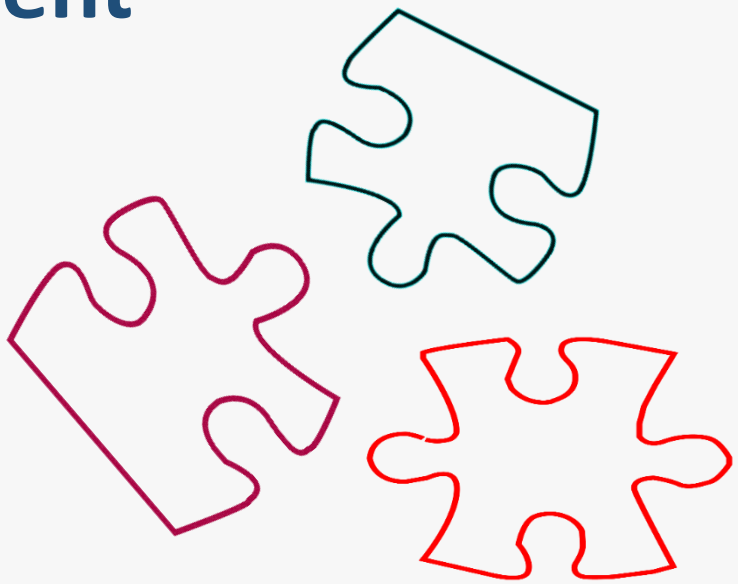
Catchments as Asset Systems: a Transdisciplinary Approach for Integrated Water Resources Management

Chrysoula Papacharalampou

Doctoral Researcher
Water Innovation Research Centre
Department of Mechanical Engineering
University of Bath



Defra 2016: roadmap towards resilience in the water sector

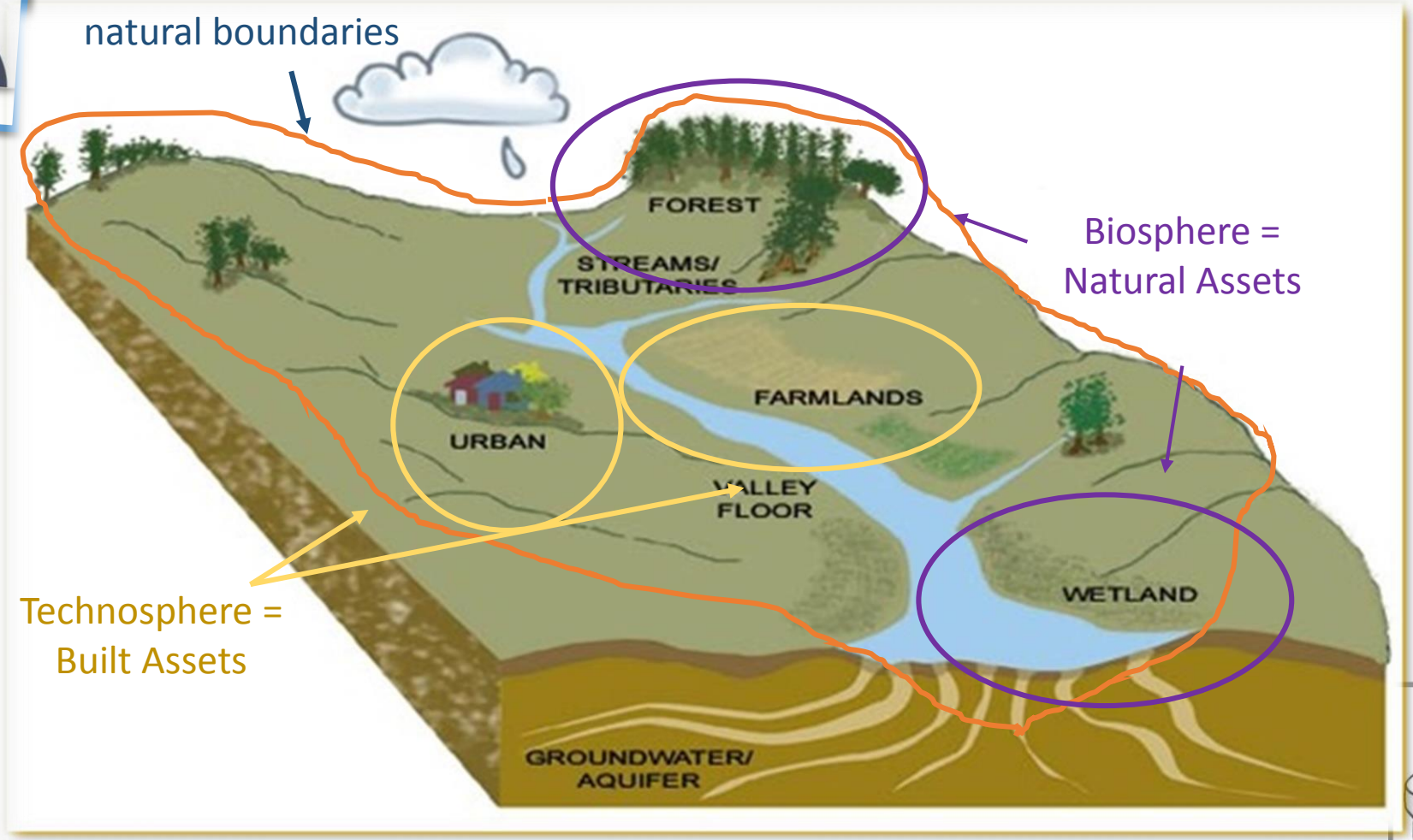
OFWAT 2015: market reform & resilience duty

vehicle towards resilience → asset management

Asset: an item or entity that has potential or actual value to an organisation

Asset Management: focus on physical asset, performed according to the BS ISO 55000:2014 (PAS 55)

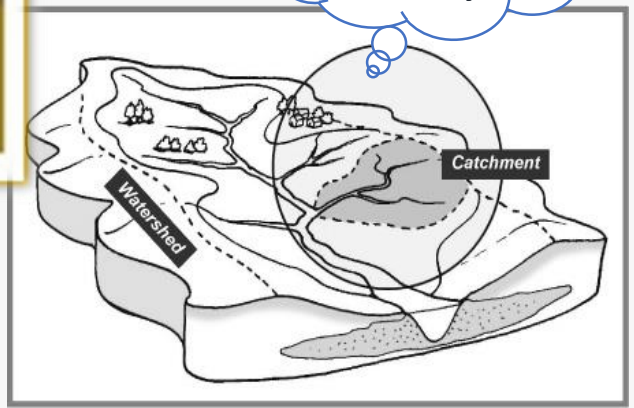
create **a structured approach for integrating natural capital** in the asset management portfolio of the water sector

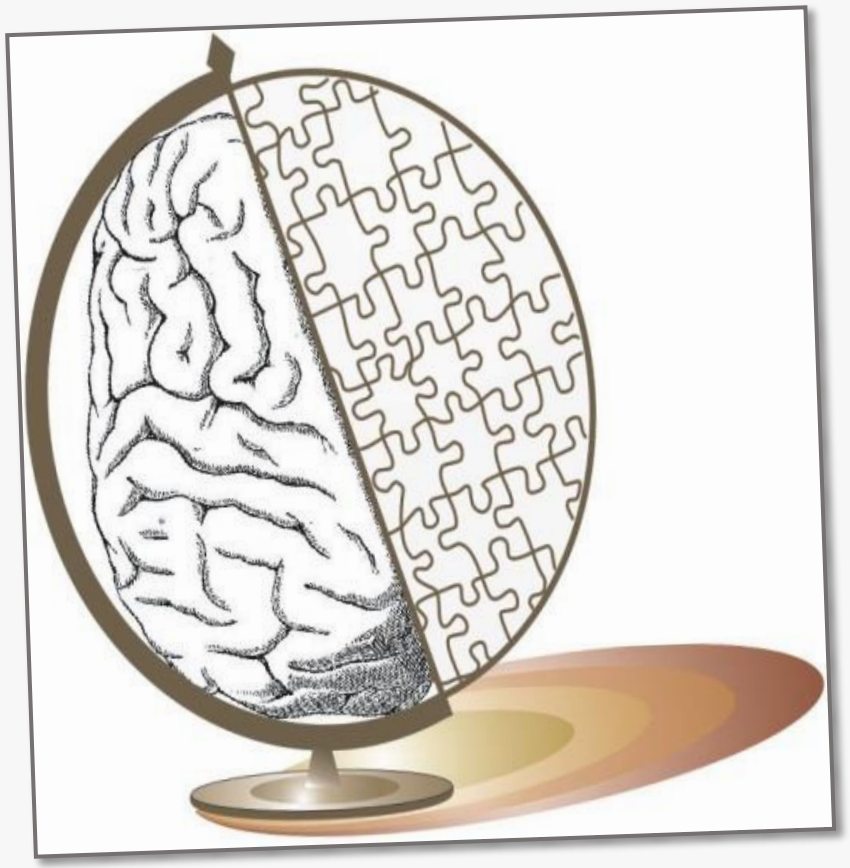


Catchment : the area from which a surface watercourse or a groundwater system delivers its water

(*Oxford Dictionary of Earth Sciences, EU Water Framework Directive, 2000/60/EC*)

Catchment = spatial unit of analysis

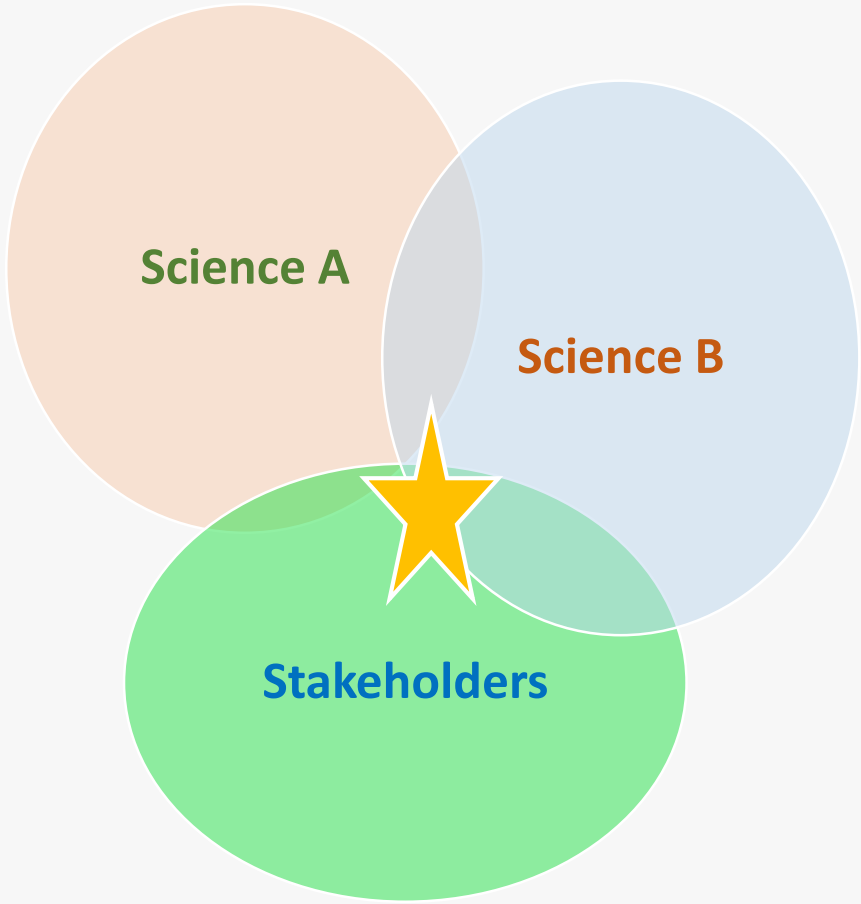




Various disciplines linked & need for synthesis of tools

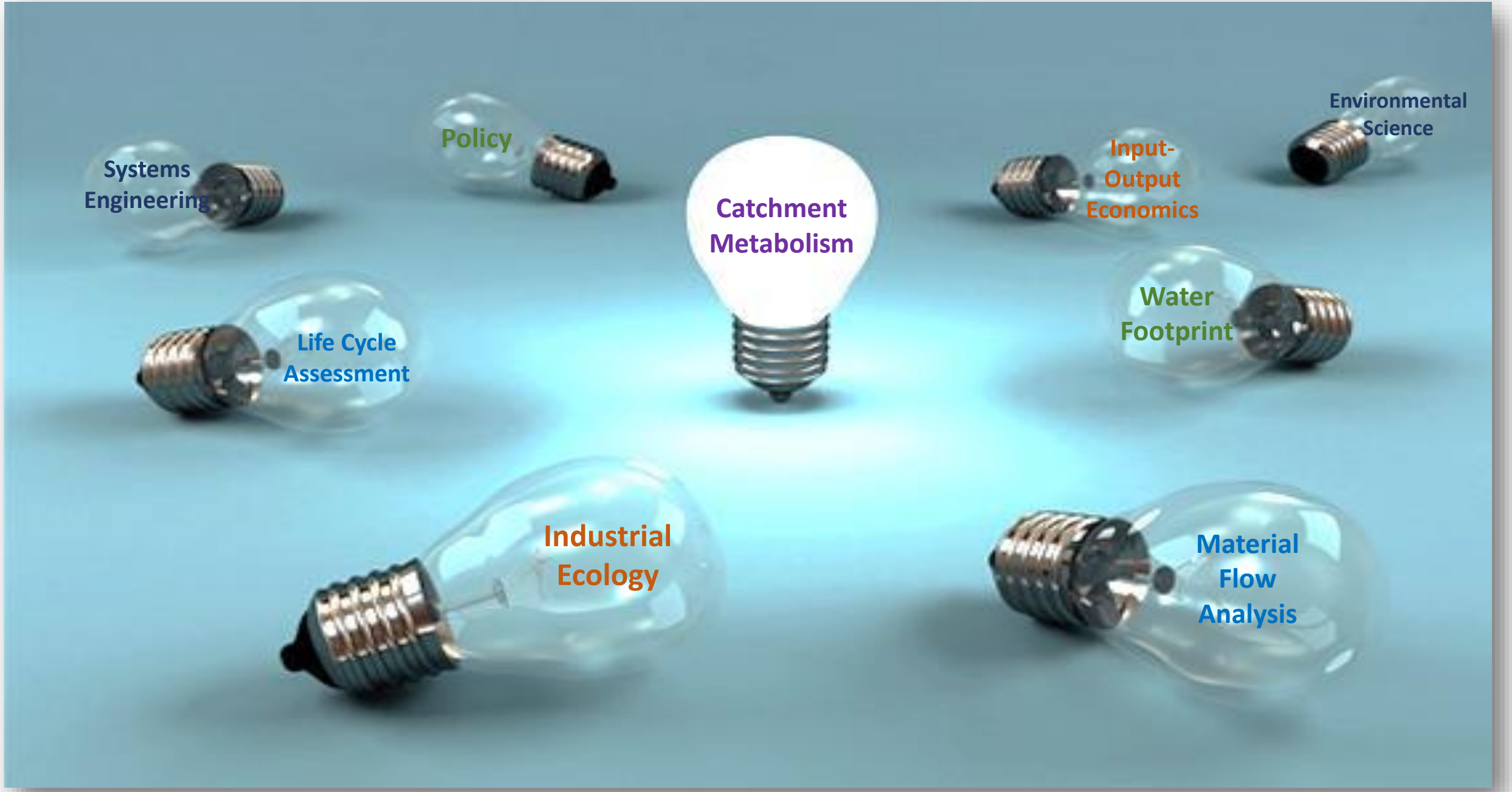
→ **Transdisciplinary research → flexibility & systems view**

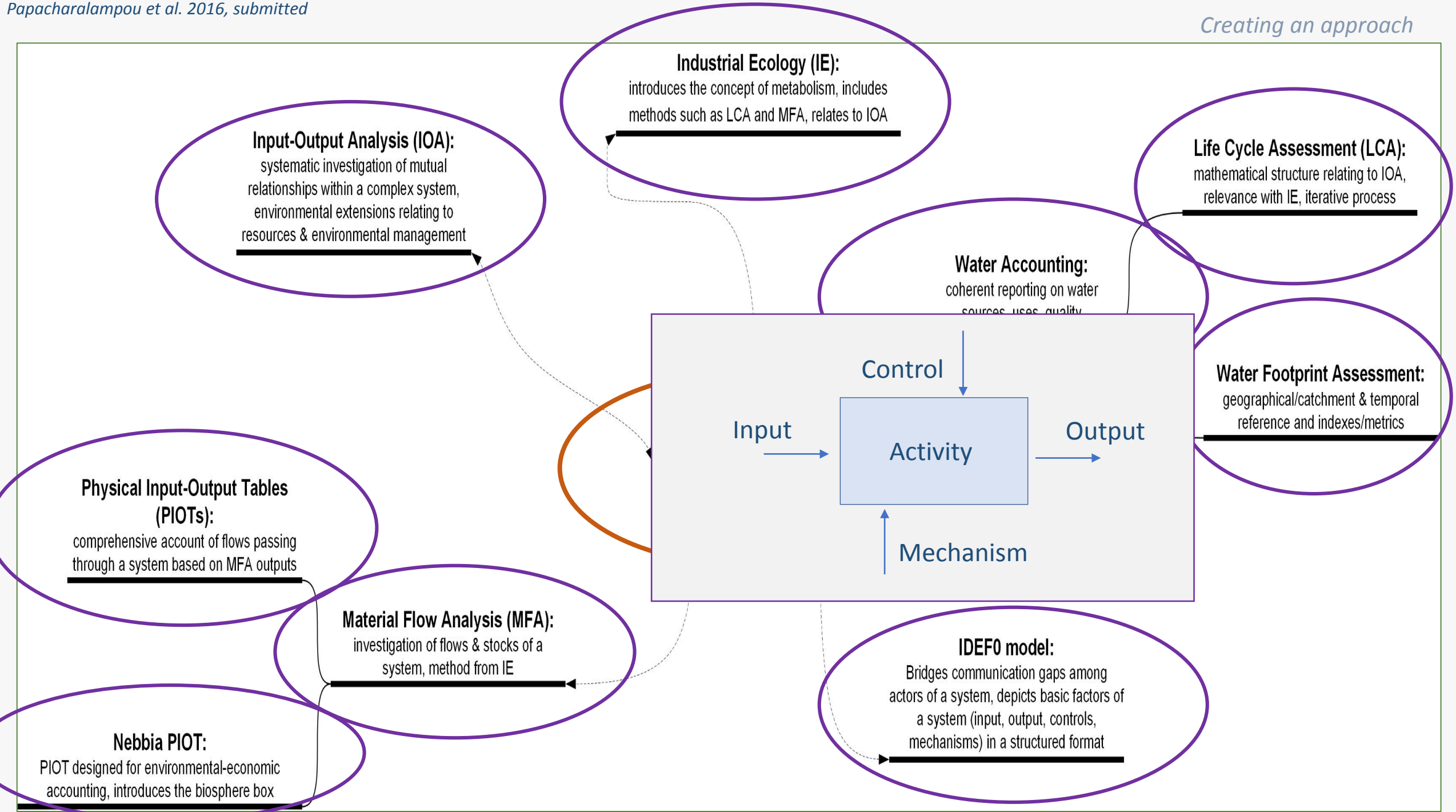
The **design strategy** requires an **evolving & comprehensive approach,** constructed in service of the research goal

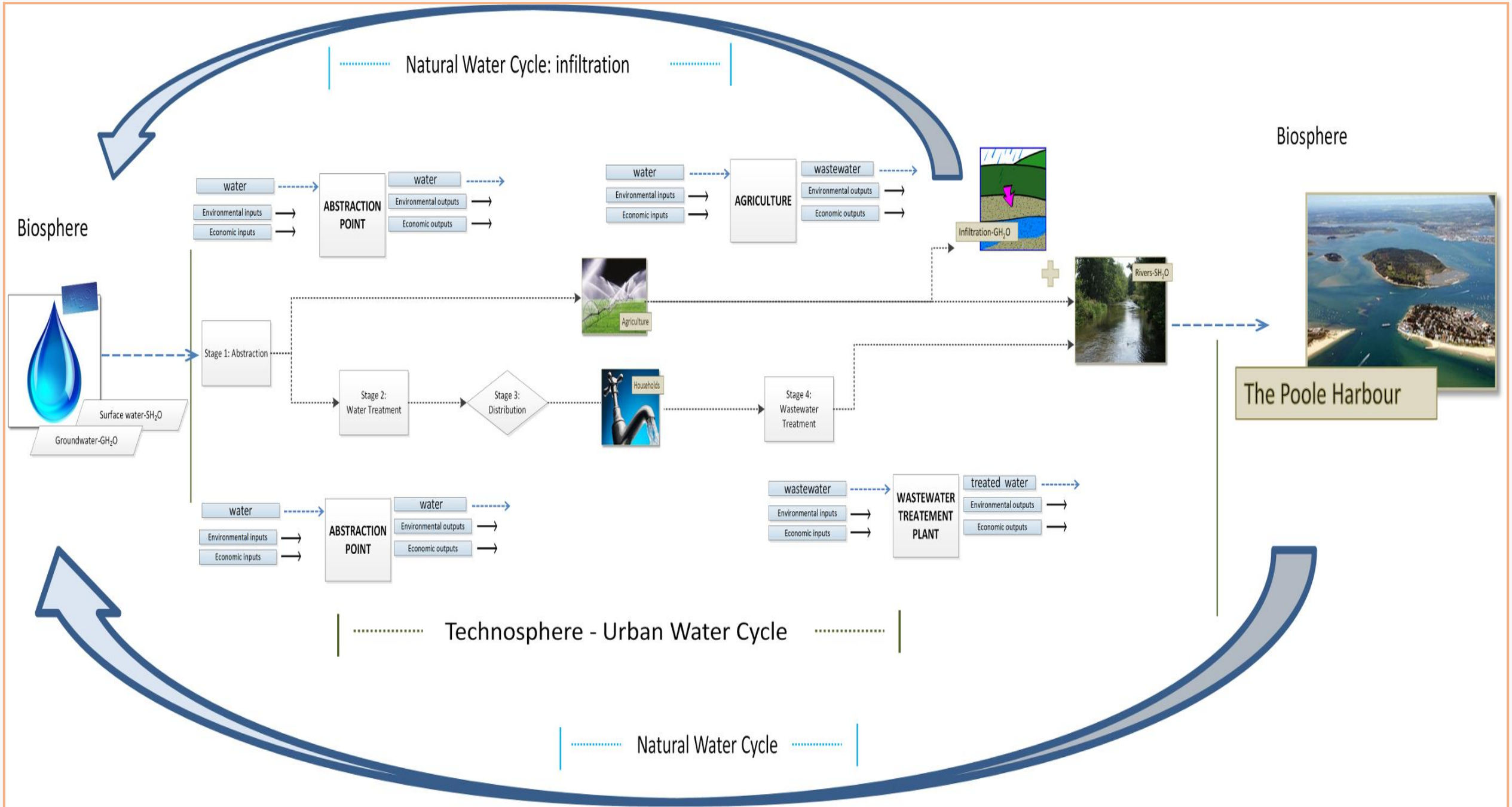


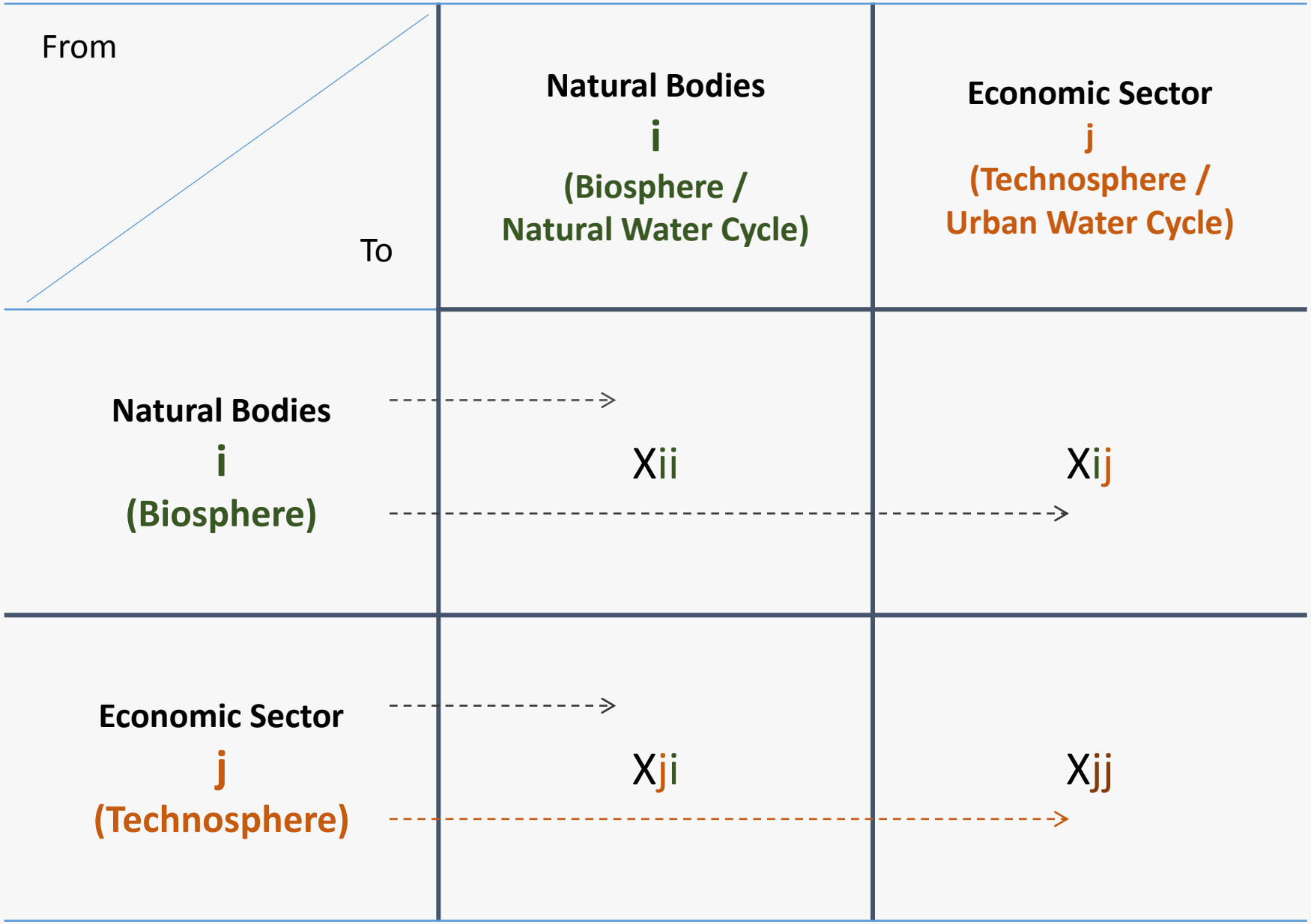
Integrated Catchment Management →

- sustainable, integrated solutions for a range of uses & stakeholders
- a conceptual framework requiring **creative conceptualisations**

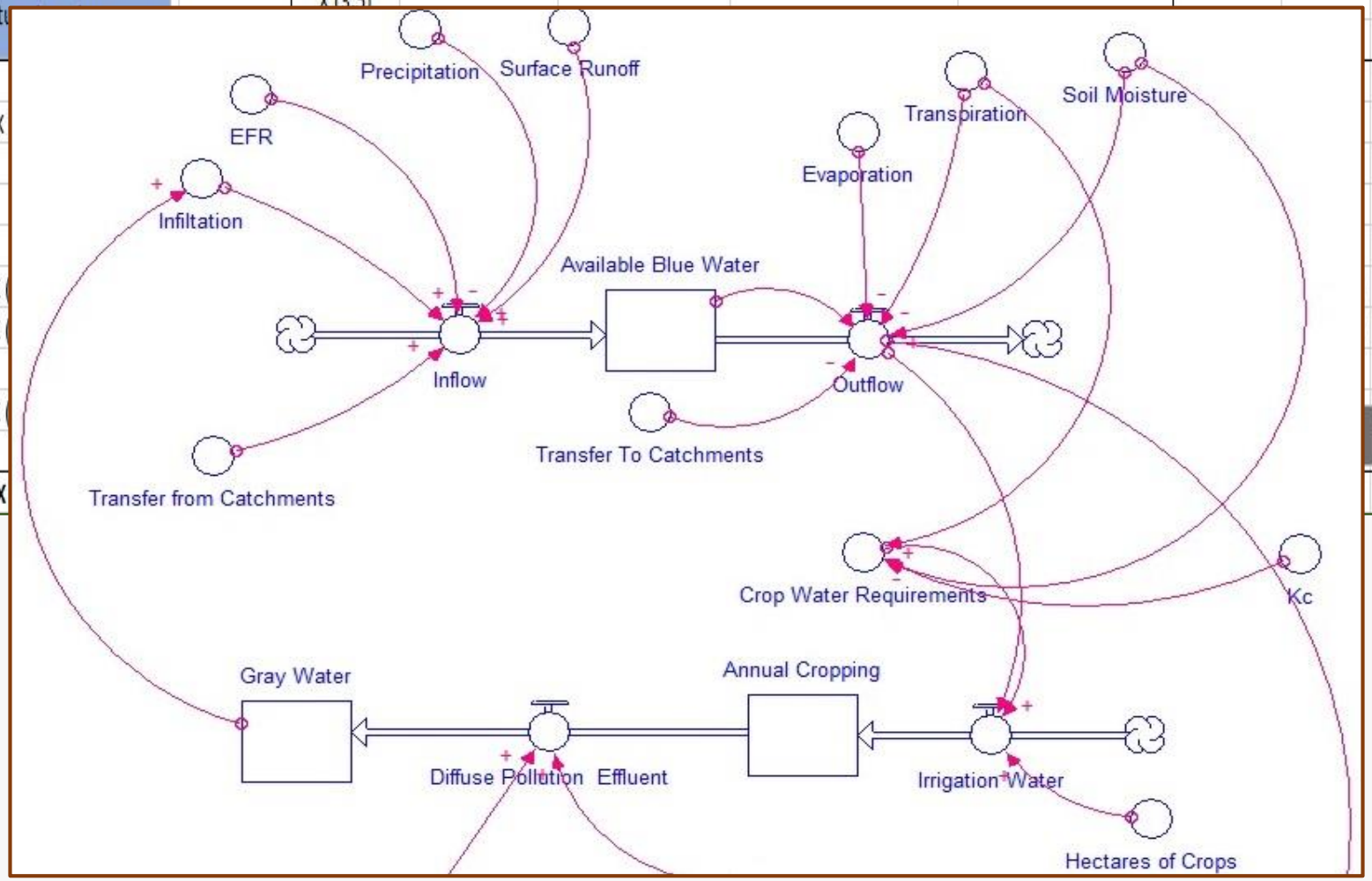

Systems Engineering
Policy
Catchment Metabolism
Input-Output Economics
Environmental Science
Life Cycle Assessment
Water Footprint
Industrial Ecology
Material Flow Analysis

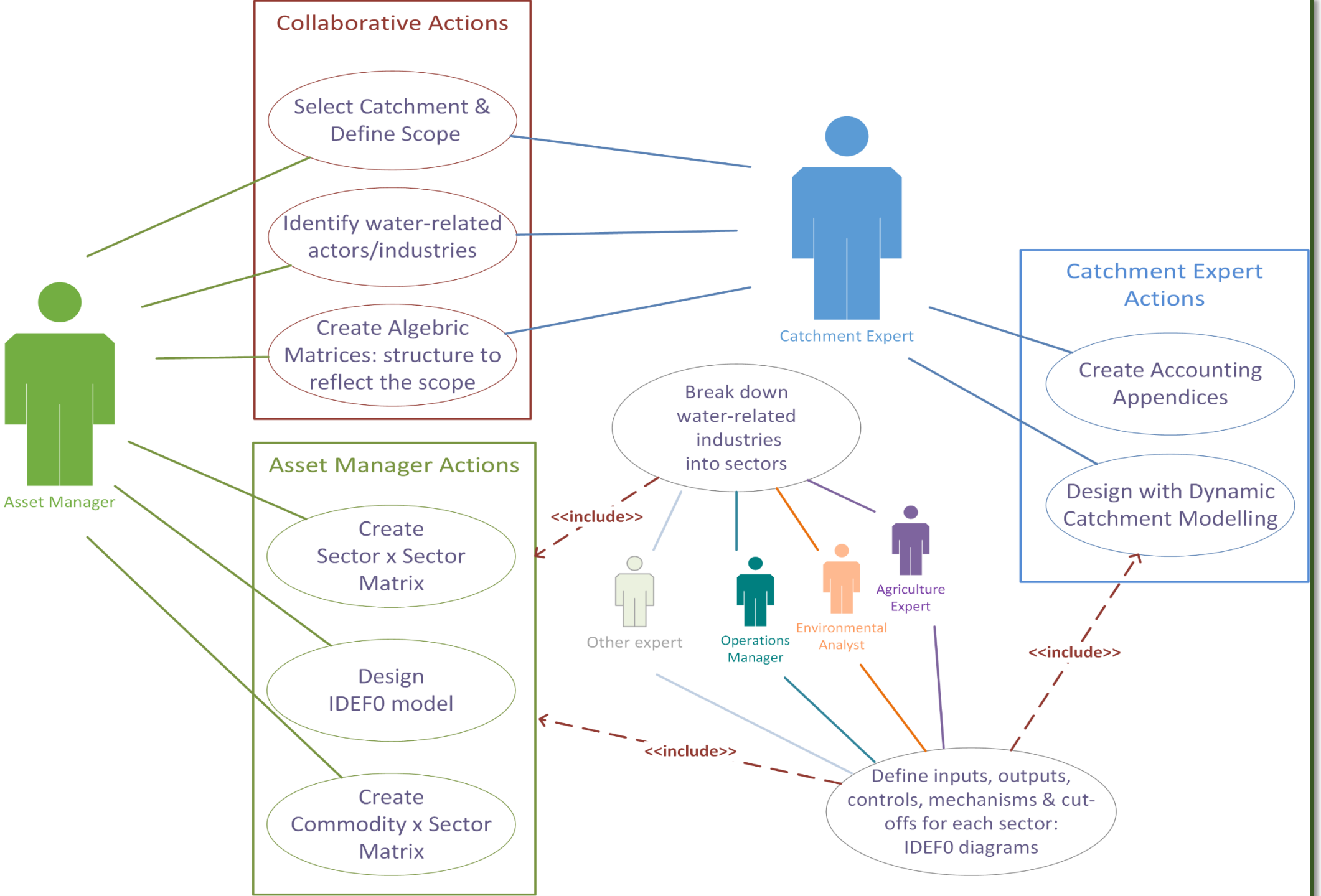

Industrial Ecology (IE):
introduces the concept of metabolism, includes methods such as LCA and MFA, relates to IOA
Input-Output Analysis (IOA):
systematic investigation of mutual relationships within a complex system, environmental extensions relating to resources & environmental management
Life Cycle Assessment (LCA):
mathematical structure relating to IOA, relevance with IE, iterative process
Water Accounting:
coherent reporting on water
Water Footprint Assessment:
geographical/catchment & temporal reference and indexes/metrics
Control
Input
Activity
Output
Mechanism
Physical Input-Output Tables (PIOTs):
comprehensive account of flows passing through a system based on MFA outputs
Material Flow Analysis (MFA):
investigation of flows & stocks of a system, method from IE
Nebbia PIOT:
PIOT designed for environmental-economic accounting, introduces the biosphere box
IDEF0 model:
Bridges communication gaps among actors of a system, depicts basic factors of a system (input, output, controls, mechanisms) in a structured format


Natural Water Cycle: infiltration
Biosphere
water
Environmental inputs
Economic inputs
ABSTRACTION POINT
water
Environmental outputs
Economic outputs
water
Environmental inputs
Economic inputs
AGRICULTURE
wastewater
Environmental outputs
Economic outputs
Infiltration-GH2O
Biosphere
Rivers-SH2O
The Poole Harbour
Surface water-SH2O
Groundwater-GH2O
Stage 1: Abstraction
Agriculture
Stage 2: Water Treatment
Stage 3: Distribution
Households
Stage 4: Wastewater Treatment
water
Environmental inputs
Economic inputs
ABSTRACTION POINT
water
Environmental outputs
Economic outputs
wastewater
Environmental inputs
Economic inputs
WASTEWATER TREATEMENT PLANT
treated water
Environmental outputs
Economic outputs
Technosphere - Urban Water Cycle
Natural Water Cycle


From
To
Natural Bodies
i
(Biosphere /
Natural Water Cycle)
Economic Sector
j
(Technosphere /
Urban Water Cycle)
Natural Bodies
i
(Biosphere)
Xii
Xij
Economic Sector
j
(Technosphere)
Xji
Xjj

		Ecosystem Functions				Water Services					Agriculture					
		Water Cycle				Urban Water Cycle					Annual Cropping			Livestock		
		Atmospher	ydrospher	Pedoshpere	Lithosphere	Abstraction	Water Treatment	Water Distribution	WasteWater Distribution	WasteWater Treatment	Irrigation	Harvest	Fertilising	Watering Animals	Feed	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Atmosphere	1	X(1,1)				X (1,5)	X (1,6)	X (1,7)	X (1,8)	X (1,9)	X (1,10)	X (1,11)	X (1,12)	X (1,13)	X (1,14)	**X (1,n)**
Hydrosphere	2		x(2,2)				X (2,6)		X (2,8)		X (2,10)	X (2,11)				**X (2,n)**
Pedoshpere	3	*aii* -natu				X (3,5)								*aij*-nature to technosphere		**X (3,n)**
Lithosphere	4												X (4,12)			**X (4,n)**
Abstraction	5	X (5,1)												X (5,13)		**X (5,n)**
Water Treatment	6	X (6,1)	X											X (6,13)		**X (6,n)**
Water Distribution	7	X (7,1)											X (7,12)	X (7,13)	X (7,14)	**X (7,n)**
WasteWater Distribution	8	X (8,1)											X (8,12)	X (8,13)		**X (8,n)**
WasteWater Treatment	9	X (9,1)											X (9,12)	X (9,13)	X (9,14)	**X (9,n)**
Irrigation	10	X (10,1)	X										X (10,12)	X (10,13)		**X (10,n)**
Harvest	11	X (11,1)	X											X (11,13)		**X (11,n)**
Fertilising	12	X (12,1)												X (12,13)		**X (12,n)**
Watering Animals	13	X (13,1)	X													**X (13,n)**
Feed	14	X (14,1)													X (14,14)	**X (14,n)**
		X (n,1)	**X**										**X (n,12)**	**X (n,13)**	**X (n,14)**	





Papacharalampou et al. 2016, submitted

Thank you!

Questions?

contact details

email: cp620@bath.ac.uk

telephone: +44 (0)1225 38937

Essex Water

EPSRC Engineering and Physical Sciences Research Council

University of Bath